Space Weather Technical Forecast

Issued on Friday, 26 May 2023 at 13:24 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of R1/R2 radio blackouts. Active high energy electron fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with one M1.1 flare peaking 25/1446 UTC, from AR3312. This is a small and faint region but magnetically atypical with leader and trailer both positive polarity, either side of a negative spot, giving it a gamma Mount Wilson type. This region has been gradually declining however. The largest region is AR3315, however this is a relatively simple east-west aligned bipolar region, although it does contain a small and weak delta amongst its intermediate spots, and continues to slowly grow. The train of three spots in the northeast AR3314, AR3311 and AR3313 (from east to west) continue to simplify and spread. AR3314 is now the most likely flare source of these, as a small but compact bipolar spot. AR3311, while historically the most active of these spots, has now simplified to a more open bipolar structure. AR3310 persists as a large, mature region with associated smaller spots to the north fading. AR3316 is a new region in the northeast that is currently small and simple but with ongoing flux emergence.

The M1 flare from AR3312 produced a weak and narrow CME, that has been assessed as likely having an Earth directed component, albeit weak with little impact anticipated with its arrival late day 4 (29 May) or just after. No other Earth-directed CME's have been observed.

Solar Wind / Geomagnetic Activity: Solar winds observed at L1 by ACE show a waning fast wind, easing from elevated levels of 600 km/s to be slightly elevated near 450 km/s. Density is currently at or below average. The total IMF strength, Bt was weak at 2-5nT, with the north-south component Bz, weak and variable. Phi angle was mainly negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp1-3).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV at GOES-16) has remained at Background levels throughout. High energy electron flux (greater than 2MeV at GOES-16), rose was mainly High, with a brief spells of Moderate from 26/0200-0615 UTC. Peak flux was 3830 pfu at 25/1510 UTC. The associated 24 hour fluence was Active (above 1e8 integrated pfu) with a rising trend. The 26/0000 UTC observation was 1.36e8 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is forecast with isolated M-Class flares possible. These perhaps most likely from developing AR3315 or the more complex AR3314, however a number of other sunspots also have the potential for M-flares.

Solar Wind / Geomagnetic Activity: A weak CME from 22 May is expected to miss Earth day 1 or early day 2 (26 or 27 May), however a glancing influence cannot be ruled out as it passes. A further CME from 25 May is expected to arrive late on day 4 or just after (29 or 30 May), however this also a weak CME with minimal observable impact currently anticipated. Otherwise current slightly elevated solar winds are expected to continue to very gradually ease, before the arrival of the next coronal hole fast wind, most likely on day 4, from CH07. Mainly Quiet

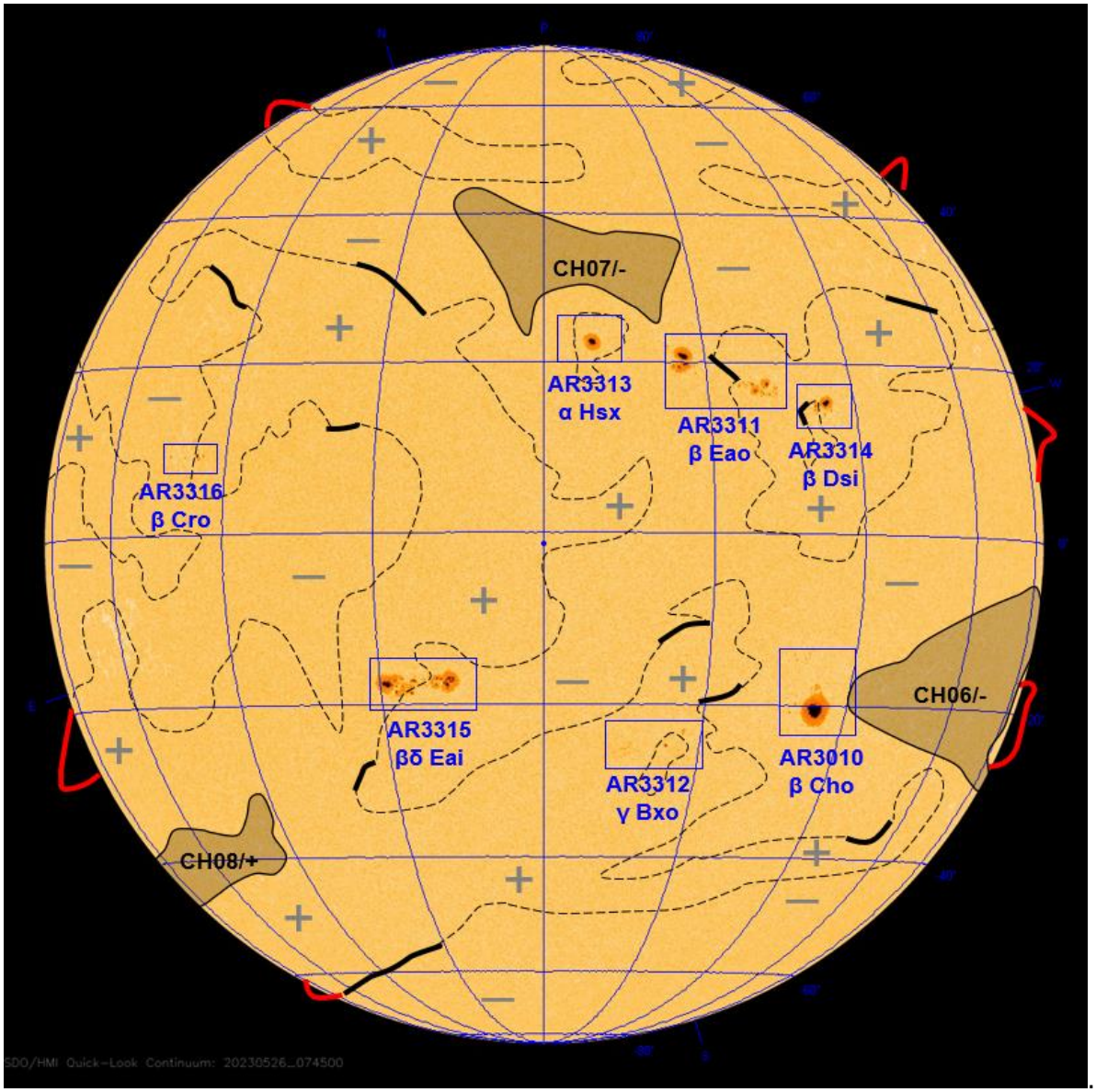
Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

geomagnetic activity is expected, with Unsettled intervals (Kp0-3). Mainly Quiet geomagnetic activity is expected, with Unsettled intervals (Kp0-3). There is the potential for isolated Active (Kp4) spells and perhaps a slight chance of G1 Minor Storms (Kp5) day 1 or 2 (26 or 27 May) or more likely day 4 (29 May).

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at Background levels. High energy electron flux (greater than 2MeV) is expected to continue at High levels for much of the period, but with a chance of dropping out due to any CME glance that occurs later day 1 or early day 2 (25 or 26 May), or more likely day 4 (29 May) with any fast wind or further CME arrival. The associated electron fluence is likely to persist at Active (1e8 integrated pfu) but with decreasing confidence by day 3 (28 May).

Figure 1. Solar Analysis Valid 26/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Geomagnetic Storms:

There are two weak CMEs of note. The first has been analysed as likely missing Earth, passing nearby later on day 1 or early day 2 (26 or 27 May). This originated from the M1.9 flare of AR3312 with an associated coronal dimming, from the southeast disc on 22 May. This has a low chance of giving a slight enhancement as it passes. The second was from the M1.1 flare from AR3312 on 25 May. This has be analysed as likely being Earth-directed, however this is narrow and slow, with low confidence in the assessment. Any subsequent enhancement is expected to be limited, most likely occurring very late day 4 or during day 5 (29 or 30 May). No other CMEs have been assessed as Earth-directed.

Current slightly elevated solar winds, due to ongoing fast wind from CH06 are expected to only very gradually ease through the period, as indicated by enlil. The next enhancement is most likely to be from CH07. This feature is currently missing from enlil, but may bring a slight enhancement of winds, potentially to around 500km/s however this is Low confidence.

Mainly Quiet geomagnetic activity is expected, with Unsettled intervals (Kp0-3). There is the potential for isolated Active (Kp4) spells and perhaps a slight chance of G1 Minor Storms (Kp5) with any CME arrival day 1 or 2 (26 or 27 May) along with any CH HSS or CME arrival day 4 (29 May).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	5	1	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

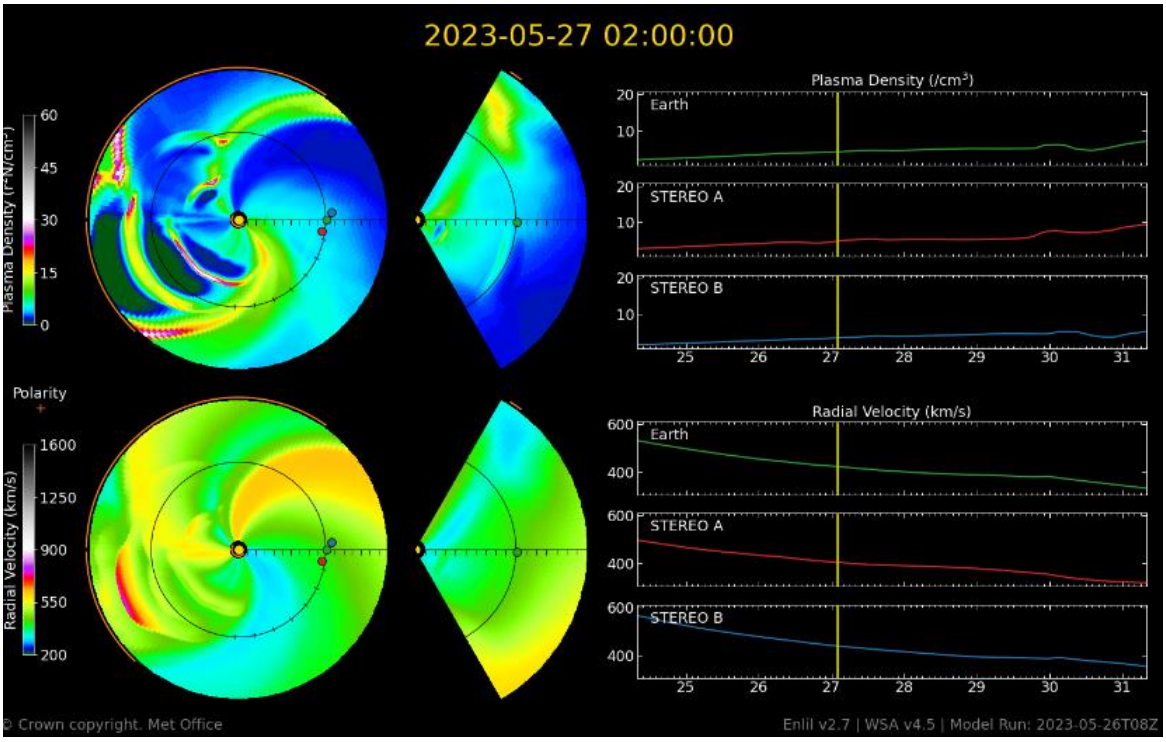
Geomagnetic Activity - Earthbound Coronal Mass Ejections

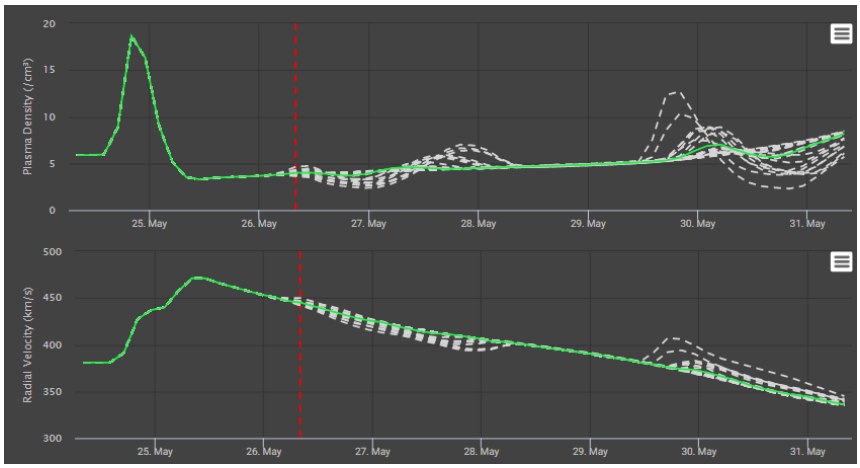
Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
22/2313	Partial	M1.9 flare AR3312	SE	353 km/s	Missing @ 27/0000 UTC	Small chance of glance.
26/0144	Partial	M1.1 flare AR3312	S	347 km/s	30/2200 UTC +/- 9hrs.	Weak glancing impact

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Figure 2: Enlil and ensemble





Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Radio Blackouts - X-Ray Flares:

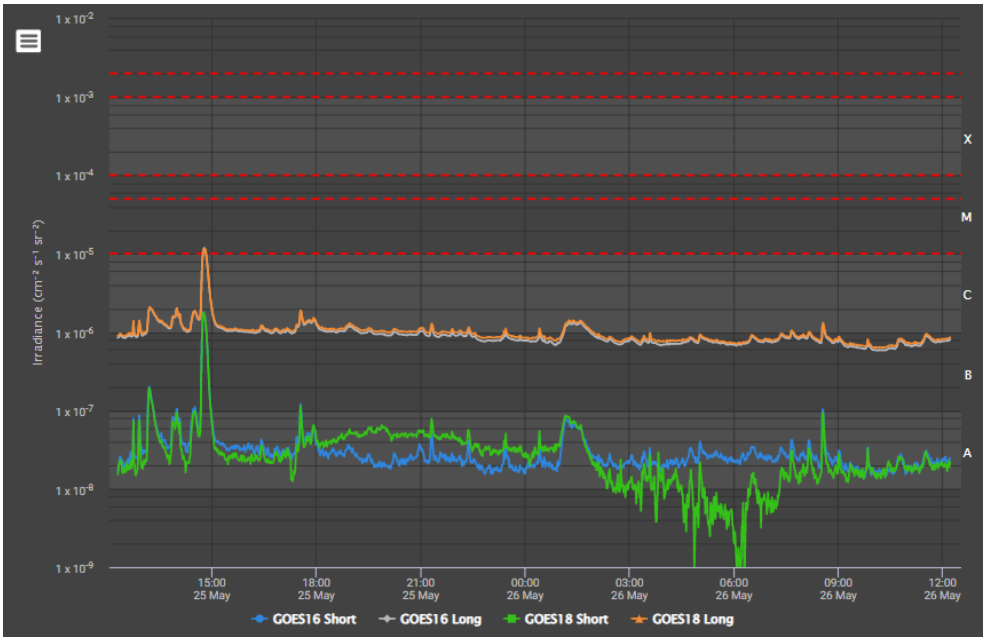
Moderate to Low activity is forecast through the period with an ongoing chance of isolated M-flares.

There are seven numbered regions, with the most developmental AR3315 just east of south-centre. This has a small delta spot on its intermediate region, but with a simple bipolar structure with little evidence of twisted magnetic field or shear. The most active region in the last 24 hours was AR3312, which is a very small but unusual gamma-type spot, with positive polarity either side of the main negative spot, likely indicative of the presence of twisted magnetic field.

AR3314, AR3311 and AR3313 form a train of spots in the northern disc that have been spreading and simplifying. A3311 was historically the most active, however the eastern most of the spots AR3314, is now the most complex, with a small but relatively compact structure. AR3310 in the southwest is a mature and large, but relatively simple spot. This region did have some associated spots to its north, that were resulting in a greater complexity, however these are now fading. AR3316 is the newest region, in the east, with ongoing flux emergence, but is currently small and simple.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	40	40	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: GOES 16-18 X-ray Flux



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, as observed by GOES16, is at Background levels and is currently expected to remain so throughout the period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy (greater than 2 MeV) electron flux as observed by GOES-16 is mainly High, with brief reductions to Moderate during daily minimum. Only a very gradual reduction of peak rates is expected. However, there is a CME passing close to Earth later on day 1 or early day 2 (26 or 27 May). This is expected to miss, however any impact from it could result in values dropping out sooner than anticipated, before some uncertain recovery occurs later on day 2. A further more definitive reduction is possible on day 4 (May 29) from the arrival of any CIR ahead of the fast wind from CH07, along with another potential weak CME arrival later in the day.

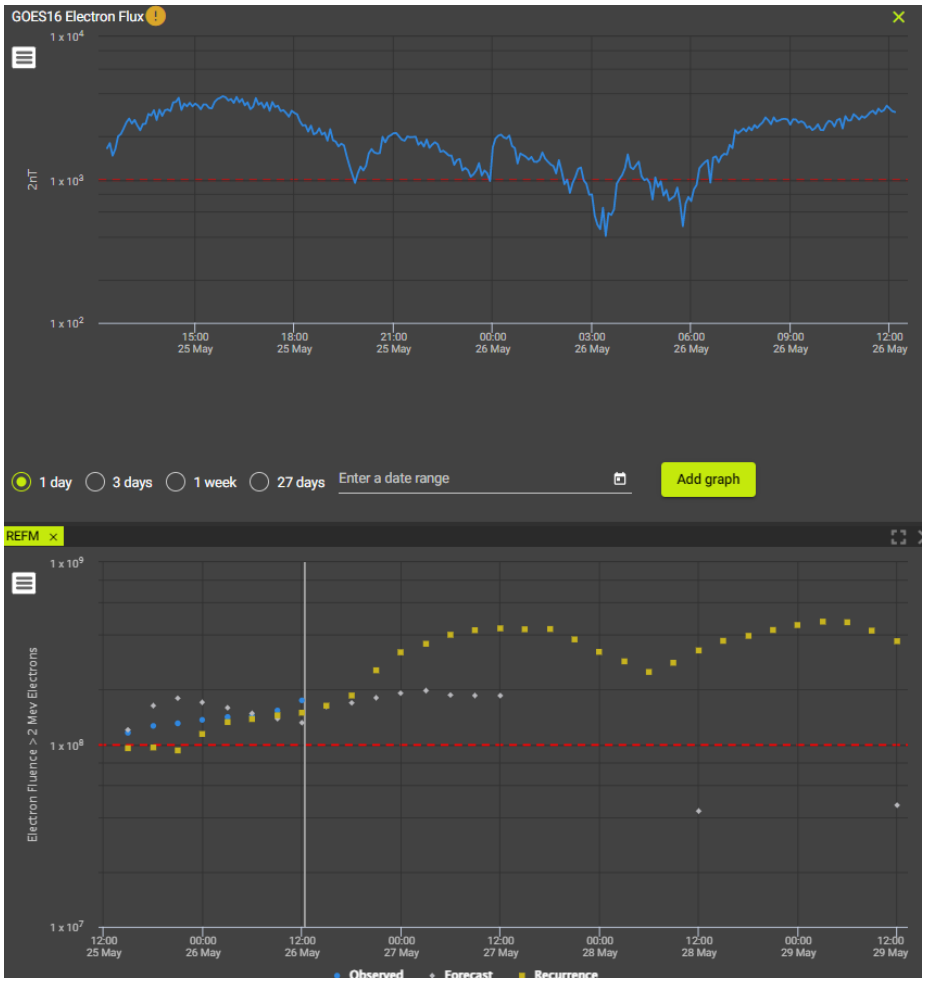
The associated 24 hour fluence is expected to be Active throughout (greater than 1e8 integrated pfu), but with reducing confidence day 3 (28 May) onward primarily due to the CME's in the forecast, but also the natural decay of flux. This is supported by recurrence from the last 27-day rotation which is currently considered better guidance than REFM.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	99	80	80
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Figure 4: GOES-16 Electron Flux and REFM



© Crown Copyright 2023. All Rights Reserved.